# A new, simple hydrogen approach is offering new opportunities to develop Ga2O3 as a material for bipolar transistors

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In a paper out April 9 in *Nature Scientific Reports*, scientists from Los Alamos National Laboratory, Bowling Green State University and other partners in the U.S. and Germany demonstrate for the first-time p-type conductivity in Ga2O3 as well as huge increases in the n-type conductivity. With this change, Ga2O3 has improved potential for use in power electronics, with reduced energy consumption and cost.

This is accomplished by changing the amount of hydrogen that is introduced into the material. Simply by changing the amount of hydrogen, the team demonstrated they can shift not only the magnitude of the conductivity, but its very nature. With just a little hydrogen, the material is p-type, but adding more leads to n-type conductivity. These results provide new opportunities to develop Ga2O3 as a material for bipolar transistors. This simple hydrogen approach could also provide a promising technology for developing other semiconductor materials.

Bipolar transistors are semiconducting devices that combine an n-type semiconductor (governed by electrons) and a p-type semiconductor (governed by holes, or missing electrons) to create a junction where the current can be easily controlled via a small control current, enabling amplifiers and switches and other electronic components such as LEDs.

To create the two different regions, typically two different materials are combined to create these devices. However, using a single material opens up many opportunities and that is precisely what is done with silicon through various types of doping. If the same could be achieved with a wide-bandgap material such as Ga2O3, whole new types of high power devices could be developed. This is because materials such as Ga2O3 don’t lose as much energy when they are used in devices, making those devices much more durable and efficient.

As a result, $Ga_2O_3$ is being studied world-wide as a high-power device material that would transform power electronics, leading to drastic decreases in the energy consumption, cost, and size and weight of our everyday devices. The problem is that no one has been able to make $Ga_2O_3$ a p-type conductor.

The paper: Chemical manipulation of hydrogen induced high p-type and n-type conductivity in $Ga_2o_3$, *Nature Scientific Reports* DOI: https://doi.org/10.1038/s41598-020-62948-2

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